



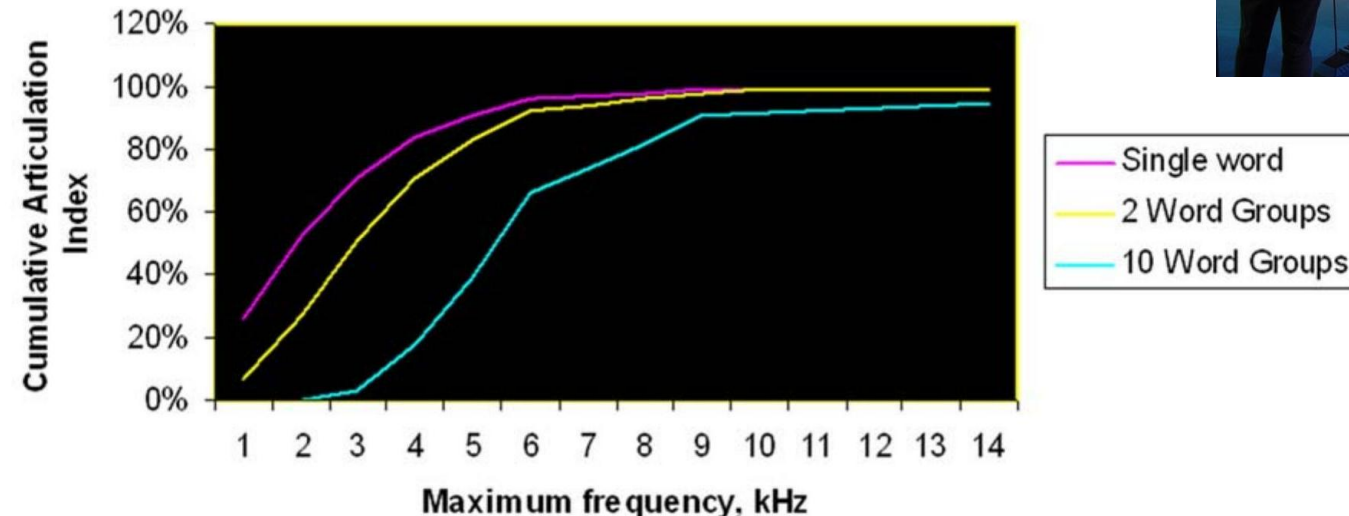
High-quality comms and DECT NR+

Tim Whittaker & Paolo Gatto



High-quality communications is vital for professional users

- Telephony bandwidth ($\approx 3.4\text{kHz}$) in comms causes fatigue when used long-term
- BBC research in the 1960s reckoned $\geq 10\text{kHz}$ audio bandwidth was required for talkback and intercom



Rodman, J, *The effect of bandwidth on speech intelligibility*, 2003

- More recent research suggests that there is a useful contribution for comms from audio bandwidth extended up to 14kHz
- If music is carried by the comms system (e.g. in foldback applications), full bandwidth audio could be desirable



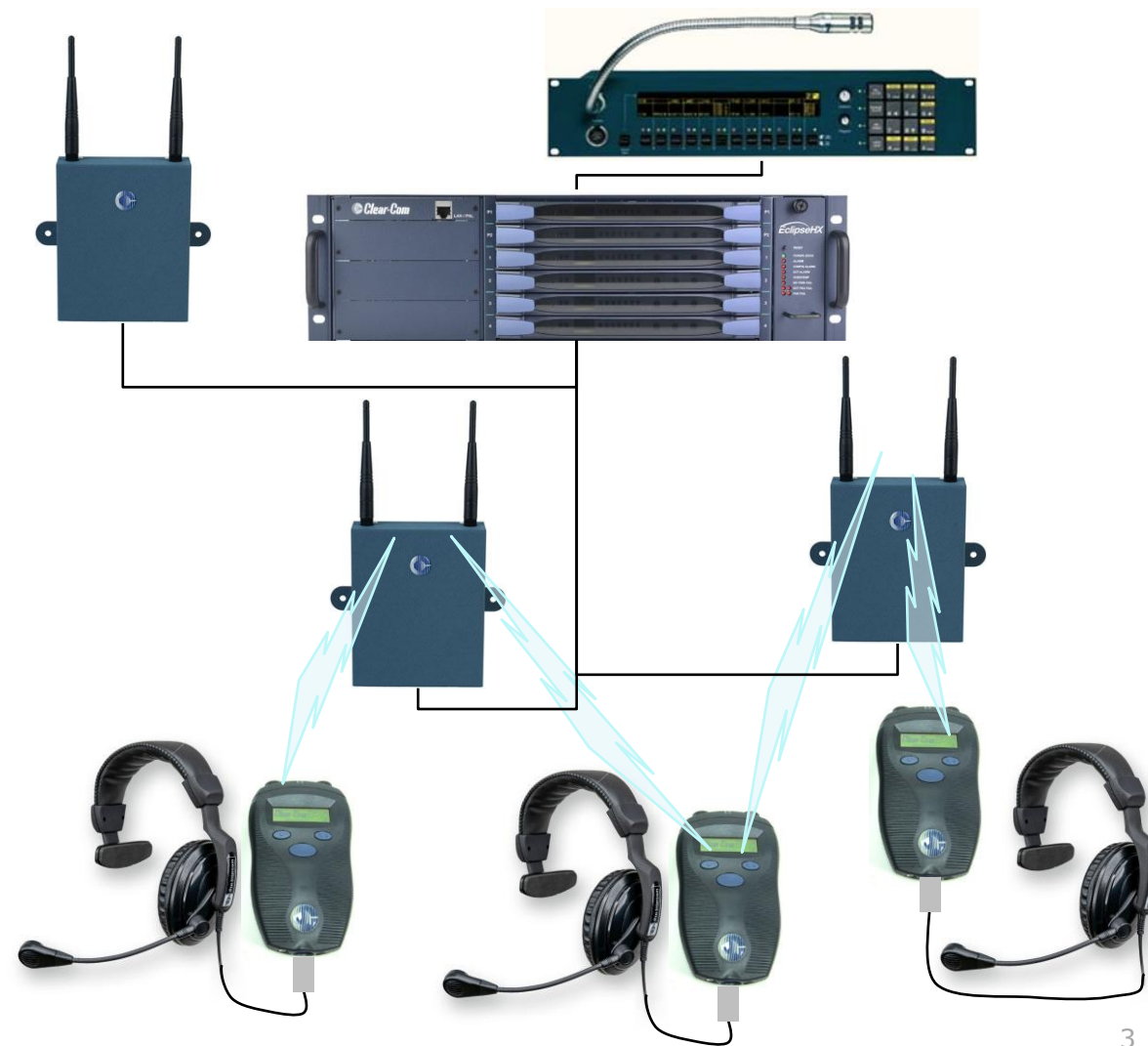
Breaking the cord: DECT has served us well for over 25 years

Fully-functional wireless extension to matrix intercom system (2001)

- Before that, a small subset of users (e.g. TV floor manager) had a simple wireless transceiver
- The wireless extension allowed all 'non-fixed' staff to have a fully-functional terminal
- Cellular system allowed staff to roam across site (TV dressing rooms, technical areas, canteen...)
- 64kbit/s payload delivered 7.5kHz voice bandwidth (with the codecs available) and system signalling



Full
function





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High-quality audio distribution system (2010)

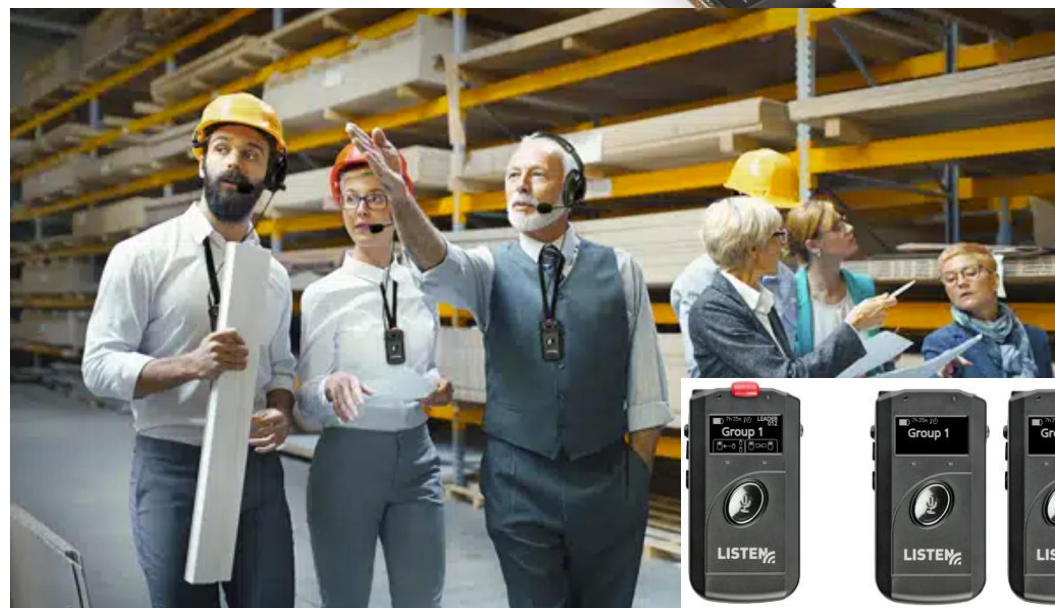
- Added true multicast functionality to DECT
- Upstream acknowledgement scheme from receivers met spectrum etiquette and regulatory requirements
- Audio bandwidth 15kHz stereo or 2-language, using early CELT (now Opus) codec

Two-way tour-guide (2015)

- Push-to-talk for participants – sets up a duplex connection for the duration
- 15kHz mono audio with Opus codec
- Enhanced (2020) to add sub-groups (sub-masters are DECT HyP)

First cellular cardiac monitor (2004)

- DECT moved into 1.4GHz WMTS band (USA)
- Encapsulated TCP/IP messaging from instrument to monitoring station
- Support of 500+ users





What's good and bad about legacy DECT

Very good

- ✓ A relatively clear piece of spectrum!
- ✓ Very robust coexistence mechanism (DFA) allows multiple systems, and multiple transceivers per system
- ✓ Solid / simple frame structure allows easy understanding of what's going on
- ✓ Excellent silicon support at reasonable cost

Not so good

- ✗ Short symbol duration (890ns) does not perform well in high multipath
 - Symbol equalization possible but not easy
- ✗ The prescribed frame structure sets a minimum audio latency
 - Mitigated by splitting into sub-frames
 - But at the cost of number of simultaneous links possible
- ✗ Flexibility limited by need to pair time-slots



What an audio-capable NR+ MAC layer needs

A coexistence mechanism (with other scheduled access systems) at least as good as DFA

A satisfactory coexistence mechanism with and from random-access systems

- IoT needs awareness of the '10ms' users and vice versa
- How do we deal with unsynchronised co-located networks (causing sliding interferers)
 - How does that work in OFDM?
 - Do we need to reinstate the Z-field?

Configurations to allow low latency (radio mics <5ms, ideally <2ms)

- Lowest practical over-air latency with full slots is probably 2.1ms
- This would allow 2 users plus space for handovers etc.
- At this very high data rate, a codec may not be needed!

Intermediate latency allows for more users per FT

- 4.6ms over-the-air latency could allow 4-5 simplex users
- Codec probably required, which will add 2 – 6 ms to this



What an audio-capable NR+ MAC layer needs (2)

Configurations to allow larger numbers of users

- Ideally, full duplex link per user, to allow the sort of control, privacy that we now enjoy
- Naturally, bearer count has a trade-off with latency
- Multiple RFPs for coverage – but as many links per RFP as possible to keep costs down
- Good re-use with distance – as the resource is limited

Configurations to support multicast

- Foldback / IEM applications
- Probably requiring some sort of RACH process for receivers to feed back to the transmitter (required for both QoS and regulatory purposes)



Larger numbers of comms users and subslots

For high user count, a duplex pair of subslots per user looks very attractive

- Maximises number of users per (relatively expensive) RFP unit

But the packet and control overhead are significant at $\beta=1$, $\mu=1$

- Only 56 RE left for the PDC (so 112 bits per packet at MCS=3)
- Could we consider for an established (and repeated) relationship between radios, a smaller PCC?



What may also be needed

Software Update Over The Air

- Less likely for audio
- Or is it better / more reliable to update in the charging dock?
- More likely, we need OTA configuration update, if some config data has to exist at the PT

Operation in different bands

- 915MHz ISM band is attractive in North America, but
- Can't rely on 'DECT-type' coexistence procedures
- Need to be resilient to other 'IoT-type' devices
- So, need a different coexistence system!



Where next?

We look forward to audio standardisation continuing apace

We need to keep the conversation about coexistence going

Keen to assist where we can...

Then let's move on and implement product for some of these opportunities!

Please feel free to ask any questions



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